Comments on Response to September 22, 2011 letter commenting on the May, 2011, Draft Groundwater Source Control Final Design Report, NW Natural GASCO Site, prepared by Anchor QEA on behalf of NW Natural and dated November 4, 2011

Submitted November 21, 2011

The following are review comments regarding the responsiveness to EPA-generated comments submitted by DEQ to NW Natural on September 22, 2011 related to the May 2011 *Draft Groundwater Source Control Final Design Report*, *NW Natural Gasco Site*. The review begins by providing a general comment related to the 12 page introductory text in the November 4th letter and associated Attachment A. Following this, EPA reviews individual responses NW Natural provided to EPA comments as presented in Attachment B. EPA reserves comment on many responses that NW Natural defers to their proposed Construction Design Report. Specifically for those EPA comments where NW Natural indicates additional information will be provided in a future report, EPA's response indicating acceptance is contingent on review of this additional information.

General Comments on Introductory Letter and Attachment A

1. In general, EPA recognizes NW Natural's desire to begin construction of the entire Hydraulic Containment and Control (HC&C) system without further study and analysis. However, despite enormous amounts of data collected, there remains:

    - Uncertainty in the long-term sustainability of the HC&C system due to well efficiency, hydraulic properties of the aquifer and limits to available drawdown in some locations.

    - Unconfirmed statements of capture effectiveness for key design features (e.g. interceptor trench)

    - Unexplained concepts related to hydraulic containment (e.g. control of lower alluvium discharge with upper alluvium extraction wells).

    Much of the uncertainty that remains could be resolved with additional analysis using existing data and presenting this analysis and explanation fully in the text.

2. Despite a consistency in adhering to a HC&C system for source control, NW Natural's design elements and concepts have changed many times since the HC&C concept was originally introduced. The Draft Final Design presented in May 2011 was no exception. This document had several newly introduced construction elements and concepts for hydraulic control, the least of which include:

a. Containment of contaminant flux in the fill by construction of an interceptor trench over 1,500 feet in length.

b. Hydraulic containment in the lower alluvium via extraction from upper alluvium wells.

Revisions to a design are not unusual as new information is acquired. However, with every design change, EPA expects a thorough analysis of these changes be performed to support the certainty of their function, effectiveness, and impacts to other design elements. This is an approach that works to achieve successful source control immediately after construction and at the onset of operation, which remains EPA's expectation. The opposite to this approach is one of trial and error, whereby less emphasis is placed on getting the design worked out with certainty and relying on increased post construction revisions, such as additional extraction wells, if design expectations are not met in the field.

The newly introduced elements and concepts in the Draft Final Design Report (which are likely the result of the newly acquired information) lack elaborative analysis (either analytical or numerical) and explanation to support that these new design changes will be effective. The bolstering of analysis and explanatory text in these design reports is unlikely to eliminate uncertainty completely, but it will likely achieve two things for NW Natural:

1. A reduced number of review comments and questions submitted by DEQ and EPA on the project design and,

2. Reduce recontamination potential by minimizing the need for implementation of post construction contingencies, such as the installation of supplemental extraction wells.

In the upcoming Construction Design Report, EPA expects to see a more thorough analysis and explanation for the comments submitted on the Draft Final Design Report that are proposed for deferral to this critical report.

Specific Comment on Introductory Letter and Attachment A

1. Introductory Letter, Page 3, Step 2 and Attachment A, Pages 9-10: These sections of text appear to contradict one another. EPA needs clarification of what exactly NW natural will and will not do related to information update and analysis using the numerical model. EPA expects additional model runs to be performed which should not involve much effort and time. These model simulations will use the new information collected from Segment 2 testing and evaluate the influence and effectiveness of newly introduced design elements and concepts such as the hydraulic containment from the interceptor

trench and upper alluvium wells. EPA understands some assumptions will need to be made; however, the significant information gathered from Segment 2 testing over the past 2 years should greatly improve the assumptions made since the model was last refined. An important design feature that can be improved with this refined predictive modeling is re-estimating the upper end of flow to be treated at the treatment plant. For example, discharge from the infiltration trench has only been loosely estimated with no supportive calculations provided in the Draft Final Design Report. In addition, extraction wells tests, refined hydraulic properties, coupled with newly introduced concepts to indirectly control discharge in the lower alluvium water bearing zone with wells completed much higher in elevation suggests that much higher flow rates may be required than anticipated. This surely supports the need to run some predictive modeling with these data and concepts to see if designed treatment capacities remain sufficient.

Attachment B – EPA General Comments

Category 1 Comments

Category	Item	EPA Comment #	EPA Comments on May 2011 Draft Final Design Report	NW Natural Response provided in November 4, 2011 Letter	EPA Response
1	**29**	**1**	EPA has several specific comments on sections throughout the draft Final Design Report that relate to the following topics. a. Capacity of the extraction wells to pump over the long-term seasonally and as a result of anthropogenic changes to the surface recharge that include site paving and a newly proposed (not in previous design documents) Fill Water Bearing Zone (WBZ) Interceptor Trench. b. Meeting the remedial action objective (RAO) of complete prevention of discharge of upland groundwater to the Willamette River. The specific comments below point to a need for further evaluation of long-term extraction well production capacity as well as deficiencies in the performance monitoring that, at its current design, presents significant uncertainty in demonstrating hydraulic control of upland groundwater discharge to the Willamette River and prevention of recontamination of riverbank and in-river sediment post cleanup.	Anchor QEA disagrees with this characterization. The extensive data collection and modeling efforts completed at DEQ's request provide substantial justification for the current design. We understand that EPA is still reviewing the conclusive findings of hydraulic capture demonstrated in the May 25, 2011 Anchor QEA report *Segment 2 Field Tests of the Programmable Logic Control and Variable Frequency Drive Well Pumps* and recognize that these comments do not necessarily reflect the findings of that report. Further, the characterization of the lower silt as continuous is not correct. The lower silt does not extend under the river so is not laterally continuous. Regardless, the Construction Design Report will restate that NW Natural is committed to achieving hydraulic containment, and it will identify contingencies that could be implemented if needed, such as additional extraction wells.	Please see our general comments provided above for clarification on EPA's characterization of the draft Final Design Report. Please also note that EPA did provide NW Natural and Siltronic Corporation review comments on the May 25, 2011 report titled *Segment 2 Field Tests of the Programmable Logic Control and Variable Frequency Drive Well Pumps* (comments dated June 30, 2011 and submitted via e-mail to NW Natural and Siltronic Corporation on July 7, 2011). Receipt of the comments was acknowledged in a July 13, 2011 email from John Edwards with Anchor QEA (consultant to NW Natural). EPA's overall impression with the May 2011 document is that the findings were conclusive that hydraulic control was attainable over a short duration for some of the wells monitored; however, hydraulic control was not demonstrated for the entire groundwater flux exiting the site and uncertainty exists that control is achievable over the full range of seasonal flux between groundwater discharge and changes in Willamette River stage. This was reinforced in EPA's July 16, 2011 e-mail response to NW Natural and Anchor QEA acknowledging that EPA's comments on the May 2011 document would be addressed with modeling to be conducted during development of the sediment EE/CA.
1	**29**	**2**	The document is void of any discussion and analysis of how well specific capacity (determined from the 2010 pumping tests) relates to available drawdown and what average extraction rates and drawdown at these rates are necessary and if they are achievable at each extraction well for long-term hydraulic control of groundwater discharge through the upper and lower alluvium.	This general comment is addressed in responses to EPA's specific comments.	Responsiveness to this comment is reviewed in the Specific Comment responses below.
1	**29**	**3**	The modeling presented in the report to support the design needs to incorporate all of the elements of the design. For example, two significant elements are not presented in the simulations, namely 1) the interception trench in the Fill WBZ and 2) changes in surface characteristics such as paving, which will decrease the recharge to the alluvium water bearing zones. EPA has the following specific comments related to this document.	This general comment is addressed in response to EPA's specific comments.	Responsiveness to this comment is reviewed in the Specific Comment responses below.
1	**31**	**1**	Based on the design report, the document is to serve as a project design report which provides the "technical and logistical information" for the construction of the interceptor trench. The document and drawings state the basic design concepts and provide good illustrations of the construction details. However, the specifications noted on drawings S9 and S10 imply that: "The interceptor trench and appurtenances are… solely the contractor's responsibility to determine the construction procedures, equipment and sequences, and ensure the completed functionality of the system resulting from construction." This implies that a final design will be prepared that describes the contractor's means and methods. EPA requests the opportunity to review the final design.	This statement was not intended to imply that another design will be prepared.	While the interceptor trench design presented in Appendix J presents the basic geometry and materials, the design will need additional details for construction. If such details are to be provided by the contractor, then the contractor should provide an Interceptor Trench Installation Basis of Design Report. This report should include equipment requirements; material requirements; field activities including trench construction, pipe placement, cleanout placement, clay cut-off wall placement, slurry preparation, and waste profiling and disposal; sequence of field activities, trench backfill specifications, and construction quality assurance. The report should also present calculations of proposed slurry trench stability used by the Contractor as the basis for selecting the proposed work platform level. The calculations should include groundwater elevation assumptions, assumed soil conditions, surcharge loading and slurry properties. EPA notes that a preliminary trench stability calculation would have been helpful in Appendix J to indicate that this construction method is indeed feasible for the site conditions. The final design should also include preparing a mix design for the bio-polymer slurry for submittal to an independent testing laboratory for testing to demonstrate that the mix design will provide sufficient support to maintain vertical trench walls, and is compatible with the site groundwater. The testing should also confirm that the bio-polymer slurry mixture can be sufficiently degraded by the specified enzyme breaker. The mix design should be included in the Interceptor Trench Installation Basis of Design Report.

Attachment B – EPA Specific Comments

Category 1 Comments

Category	Item	EPA Comment #	EPA Comments on May 2011 Draft Final Design Report	NW Natural Response provided in November 4, 2011 Letter	EPA Response
1	30	1	Section 2.1.4, pages 9 and 10: NW Natural presents profiles showing the extent of total and dissolved free cyanide, yet there is no substantive discussion about these profiles. Total cyanide concentrations appear very high adjacent to the U.S. Moorings site. More discussion should be presented in the document related to these figures and how this chemical of interest is being addressed in the overall proposed Hydraulic Control and Containment design.	Yes, more discussion will be provided in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	30	2	Section 3.1.3, page 13, paragraph 1, 5th sentence: There does not appear to be supportive analysis to provide a basis for the assumption that when a well is shut down for maintenance, other adjacent wells will be capable of increasing their pumping rates to maintain capture. To fully support this assumption, NW Natural should evaluate this analytically and using specific capacities, available drawdown, well yields necessary for capture as derived from modeling simulations, and Segment 2 constant-rate and VFD testing. Based on a preliminary review of available drawdown at current conditions, sustainable extraction rates in the upper alluvium wells are greatly limited with no additional capacity to increase pumping rates to support the loss of an adjacent shutdown well.	Yes, this type of analysis will be done and provided in the Operations Design Report and is included in the Category 2 responses.	See EPA's response to Category 2, Item 13, Comment # 2 below
1	30	3	Section 3.2.1.4: Figures showing hydraulic response within the primary water bearing units (Fill, Upper Alluvium, Lower Alluvium above the confining layer and Lower Alluvium below the confining layer) should be presented in groundwater modeled head maps and particle capture maps (both in plan and cross-section view) that illustrate extraction well influence based on long-term, sustainable, pumping rates (derived from pumping test results). These illustrations are an important spatial assessment to provide certainty that hydraulic control via extraction wells can be maintained. Currently, only particle capture is presented in plan view in Figure 3-2 with all of the particles originating in the hydraulically upgradient direction. This one figure does not provide a full evaluation of hydraulic control and capture in each of the three water bearing zones since it is unknown what unit the particles are placed vertically. As a result, it is possible that deeper alluvium flow is not evaluated in this particle track distribution, and may escape capture.	Yes, these additional figures will be provided in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	30	4	Section 3.2.1.4, page 19, paragraph 1, last bullet: Additional figures, as a result of additional modeling runs, as referenced in the bullet, do not appear in the report, or Appendix F where the groundwater modeling documents are presented. These simulations may be critical to the final design and should be provided for review.	The bullets reference specific documents prepared for ODEQ. These will be appended to the model documentation in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	30	5	Section 3.2.1.4 page 20: Groundwater inflows shown in the table need to be broken out to present the components of flow in the horizontal as well as vertical direction. For instance, NW Natural should present how much flow contribution the Fill has to the Upper Alluvium and the Upper Alluvium to the Lower Alluvium. This will help quantify the amount of flow lost to the alluvium as a result of future site paving and the interceptor trench constructed in the fill WBZ. NW Natural should evaluate these changed conditions using the model and present the results (see General Comment 3).	Yes, this table will be revised and further explained in the Construction Design Report. Yes, this will be done and the findings described in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	30	6	Section 3.2.1.4, page 20: Groundwater inflows shown in the Model Water Inflow table estimate 305 gallons per minute (gpm) of flow for the Upper Alluvium and 650 gpm of flow for the Lower Alluvium above the aquitard, while nothing is estimated for the Lower Alluvium below the aquitard. Given the inflow values, and the 10 extraction wells planned for each of the water bearing units, it would appear that each Upper Alluvium well needs to sustain a pumping rate of 30.5 gpm and each Lower Alluvium Well a rate of 65 gpm to effectively control and capture groundwater discharging to the Willamette River. However, pumping test data presented by NW Natural in their March 2011 Segment 2 Capture Zone Field Test Report suggest that Upper and Lower Alluvium wells will have difficulty meeting and/or sustaining these flow rates over the long-term (Upper Alluvium Well P8-39 shows a long-term sustainable flow rate of 2 gpm and Deeper Alluvium Well P9-92 is estimated by EPA to have a long-term sustainable flow rate of 55 gpm). This presents a discrepancy between the groundwater discharge to be controlled and the total sustainable capacity of the extraction wells based on the pumping tests that should be addressed (see Specific Comment 2 for suggestions on evaluating this issue).	Yes, these issues related to the table on page 20 will be addressed in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	30	7	Section 3.2.1.4, page 21, paragraph 1 bullets: The numerical model was further modified for the Final Design Report, but there is no discussion or documentation that presents details and results of these modifications. For example: a. Model area was extended to include U.S. Mooring site – NW Natural should explain the reason for this and what the results of this extension are to the modeled flow and calibration. b. Grid spacing was redefined from 40 x 40 ft to 20 x 20 ft – NW Natural should explain how this refinement impacted calibration and/or simulations. c. Hydraulic conductivity of the shallow alluvium was modified – NW Natural should present both the previous and newly modified distribution of the hydraulic conductivity assignments spatially on a map.	Yes, information requests 7a, 7b, and 7c, will be provided in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.

Category 1 Comments

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1	**30**	**8**	Section 3.2.1.4, page 21, last paragraph: NW Natural states that the model was not modified to reflect the numerous slug test results that indicate the Fill WBZ has an average hydraulic conductivity of less than 1 ft/day. Rather, NW Natural maintained a 10 ft/day assignment to the Fill WBZ in the model. The justification for this is the observation that the model calibrated well using the higher hydraulic conductivity and that a higher hydraulic conductivity assignment is more conservative from the standpoint of determining flow to the proposed interceptor trench and sizing of the pump and treat system. However, EPA believes a sensitivity analysis is needed to assess the degree of influence the lower hydraulic conductivity will have to the extraction system design. Since model simulations will be used to evaluate capture of groundwater at assigned flow rates, the extraction wells currently may show higher than actual pumping capacities as a result of higher recharge assigned in the model. NW Natural should re-run model simulations at hydraulic conductivities determined from site data and with the additional design elements (interceptor trench, paving, etc.) to re-evaluate extraction well placement, capacity limitations, and overall design.	This Modeling request is recommended to be conducted in preparation of the Operations Design Report following installation and testing of the complete extraction system and is addressed under the Category 2 responses.	See EPA's response to in Category 2, Item 14, No. 8 below
1	**30**	**9**	Section 3.2.1.4, page 22, last paragraph: Transient model simulations using river stage data and results from the variable rate pumping tests conducted in April 2011 to determine long-term pumping rates necessary for tidal and stage changes has not been completed (see last paragraph in Section 3.2.1.4). This analysis and its results could impact the final design and therefore should be provided for agency review before approval of the draft final design report.	Yes, the existing model will be run using the data from the April 2011 tests, and the results will be provided in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	**30**	**10**	Section 3.2.1.5: The presentation of groundwater flow vectors in Figures 3-3a continue to be difficult to visualize. These flow vectors should be presented in a more conventional approach, where a vector at the center of each finite difference cell is presented based on surrounding water levels showing the direction and magnitude of flow.	Yes, this comment will be addressed in the Construction Design Report. However, these figures show the direction and magnitude of groundwater gradients. Breaking the flow into vertical and horizontal components was done to illustrate the potential effects of gradients on DNAPL movement. This will be lost if the figures are changed to show groundwater flow vectors.	Response is acceptable pending review of additional information to be provided in the Construction Design Report. For clarity, EPA expects to see groundwater flow vectors representing the direction and magnitude of flow at the center of each finite difference cell as a response to this comment, even if that means showing an additional set of figures.
1	**30**	**11**	Section 3.2.1.9: EPA provided comments to NW Natural concerning the results summarized in the March 2011 *Segment 2 Capture Zone Field Test Report*. The comments noted issues with the assessment of capture over long-term seasonal changes and whether or not some portion of groundwater gradient reversal was being incorrectly assigned to extraction well capture. EPA is now in receipt of NW Natural's response to these comments and will provide a separate comment set related to the NW Natural's responsiveness and any additional analysis presented in NW Natural's May 2011 *Segment 2 Field Tests of the Programmable Logic Control and Variable Frequency Driver Well Pumps* report.		There is no response to this comment; EPA's comment was for clarification only, so lack of response is acceptable.
1	**30**	**12**	Section 3.2.1.9, pages 25-26, last paragraph: It is unclear what evidence NW Natural has to support the qualifier "short-term"in the last sentence and therefore this text should be deleted. This qualifier implies long-term (duration undefined) extraction in the alluvium wells will eventually capture water in the Fill, which has not been demonstrated in 72-hr test data from extraction well PW-7, PW-8, and PW-9. More likely, extraction under long-term, steady-state conditions will reach a recharge boundary from the River (seen in the PW-3 testing and evaluated in the April 28, 2008 *NW Natural Gasco, Pump Test Analysis and MODFLOW Model Summary*) that will dampen any influence the alluvium wells will have on the Fill WBZ over the long-term. This is significant, because it points to the immediate need to control discharge in the Fill WBZ, where most of the contaminated water exists, rather than rely on some long-term influence that may, or may not occur as a result of alluvium extraction well operation (see specific comment #14 for issues related to delaying control of the Fill WBZ).	DEQ's request to redesign the Fill WBZ interceptor trench and move it to the other side of the extraction wells is addressed in the response letter to which this is attached.	This comment has not been fully addressed. EPA's comments regarding the interceptor trench focus on timing and the absence of any source control in the fill until this trench is constructed. As determined from Segment 2 drilling and testing, the upper alluvium extraction wells are unable to influence and hydraulically contain groundwater discharging from the fill unit and there is no supportive analysis in the Draft Final Design Report to indicate capture would occur over time. Therefore, EPA continues to be concerned that NW Natural is not effectively addressing contaminant flux from the fill in a timely manner if nothing other than speculative long-term capture from the HC&C system is relied upon until the trench is built, which appears to be deferred to a the time when the in-water remedy is implemented.

Category 1 Comments

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1	**30**	**13a &b**	Section 3.2.2.1: The Fill WBZ Interceptor Trench is a newly proposed design that, from the text provided, does not appear to have been fully evaluated regarding the groundwater flow it will intercept. NW Natural should: a. Provide the full analysis, including calculations and assumptions for the 20 gpm estimate of flow from the Fill WBZ into the length of the proposed trench. An estimate of the flow, if 10 ft/day is used for hydraulic conductivity (as it currently is in the updated model; see specific comment 8), should be provided. b. Provide a basis that the trench location will intercept all fill groundwater discharge. For instance, the layout of the trench appears to assume the groundwater gradient is straight to the river and no groundwater exists within a measurable distance (~25 ft) of the northern property boundary. This assumption may be the result of data gaps than actual site gradient conditions. It appears some water flow in the Fill WBZ could escape capture and flow to the adjacent U.S. Mooring site based on the current design. In fact, during the remedial investigation at U.S. Moorings completed by the USACE, cyanide has been detected several hundred feet into the southern portion of the Moorings facility. Analytical and/or numerical modeling simulations should be prepared to evaluate the potential need to extend the trench footprint.	Yes, this will be provided in the Construction Design Report. Additional characterization of hydrogeology and the nature and extent of contamination is needed before the design of the Interceptor trench could be reevaluated regarding potential groundwater discharges to the U.S. Moorings site. However, the Construction Design Report will show that the interceptor trench system will be constructed to be capable of adding a section of trench if needed following the additional characterization. This Modeling request is recommended to be conducted in preparation of the Operations Design Report following installation and testing of the complete extraction system and is addressed under the Category 2 responses.	Responses to parts a. and b. are acceptable pending review of additional information to be provided in the Construction Design Report. See EPA's response to Part C, Item 15, Comment #13c below
1	**30**	**14**	Section 3.2.2.1, page 27, last paragraph: Deferring the interceptor trench construction to the time when in-river sediment and riverbank cleanup occurs presents significant delays in addressing capture of contaminant flux in the Fill WBZ. As noted from the pumping tests (see specific comment 12), the alluvium wells do not influence and capture flow through the Fill WBZ. Thus, delays in the trench design will allow contaminated flow through the Fill WBZ to enter river sediments for an extended period of time while extraction from the alluvium wells occurs. NW Natural points to the observation that flow through the fill is less than 10 percent of the anticipated total flow from the alluvium pump and treat system, but this percentage has not been supported with any analysis (see specific comment 13a). Furthermore, the sequencing of the steps starting with alluvium extraction, then interceptor trench construction/in-river work should be evaluated using the groundwater model to predict any potential issues with construction interferences and sediment recontamination.	DEQ's request to redesign the Fill WBZ interceptor trench and move it to the other side of the extraction wells is addressed in the response letter to which this is attached.	NW Natural is not addressing EPA's concern about the timing of interceptor trench construction and delaying source control of contaminant migration through the fill until in-river cleanup begins. See EPA's comment on NW Natural's response to Specific Comment 12.
1	**30**	**15**	Section 3.2.2.2.1, page 28, last paragraph, item #4: NW Natural should provide the reference to analysis, or modeling, that supports this statement.	Yes, this will be provided in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	**30**	**16**	Section 3.2.2.2.1, page 29, first paragraph: NW Natural should provide the quantitative data and analysis that supports the proposed placement of the screen intervals. Statements "shallow enough" and "deep enough to allow for sufficient drawdown to attain the pumping rates needed for gradient control" are not quantitative enough for a 100% design level document. Actual quantities of pump and screen settings, average seasonal available drawdown, and anticipated individual well specific capacities should be provided on a table and checked against pumping rates deemed necessary for gradient control.	Yes, this will be provided in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	**30**	**17**	Section 3.2.2.2.1, page 30, first full paragraph: NW Natural should provide the extraction rates assigned to each extraction well in the model that represents this capture. See specific comment 3 for additional analysis/presentation recommendations.	Yes, this will be provided in the Construction Design report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	**30**	**18**	Section 3.2.2.2.2, page 31, second paragraph: EPA disagrees with NW Natural's statement that well construction of extraction wells PW-3, PW-7, PW-8 and PW-9 were appropriate. EPA believes the gradation of the 10-20 filter pack includes too small a gradation for the selected 0.035 inch slot size. Although sanding (filter pack entering the screen) was not an issue during development and/or pumping of these wells, the lower end of this sand gradation, may have plugged the screen slots and contributed greatly to the lower efficiency (well losses) seen in these wells.[4] NW Natural should reconsider its pack selection and choose a filter pack gradation that does not reach the size of the screen slots. Furthermore, the screen intervals appear very short and only partially penetrating the water bearing zones to be controlled. This partial penetration further exacerbates well losses and effectiveness of capture. NW Natural should reconsider its well design to reduce well losses as much as possible.	Yes, these comments will be addressed in the Construction Design Report, as stated in the responses to similar DEQ comments.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.

[4] Based on EPA's analysis of pumping test data, the wells appear to average an efficiency of 20% which is far below a properly designed, constructed and developed well, which typically averages 70 to 80% (see Groundwater and Wells, Driscoll, 1986).

Category 1 Comments

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1	**30**	**19**	Section 3.2.2.5.2, pages 35-37, last paragraph starting on page 36: Capture assessment appears severely limited and simplistic. For instance, the control wells are too close to pumping wells and represent only gradient conditions between extraction wells. This does not appear sufficient to characterize complete hydraulic control of groundwater discharging through the Upper and Lower Alluvium to the Willamette River. NW Natural should include more wells, including offshore piezometers, in the real-time control of pumping rates and assessment of capture.	Yes, the Construction Design Report will include additional monitoring wells and piezometers. Please refer to NW Natural responses to DEQ general and specific comments. To clarify, each extraction well can be assigned only one control well, so the additional monitoring wells and piezometers will be used to evaluate capture in real time but will not be control wells.	Response is acceptable pending review of additional information to be provided in the Construction Design Report. To clarify, EPA feels the performance monitoring plan in the Construction Design Report needs a better explanation in terms of how and when hydraulic capture is assessed using data downloaded independently from the established monitoring wells/piezometers and integrated into the proposed single control well.
1	**30**	**20**	Section 3.2.2.5.2, page 37, second full paragraph: It is uncertain when wells instrumented with transducers will be evaluated to verify gradient reversal has occurred in deeper portions of the alluvium water bearing zones as measured by the offshore piezometers and upland wells. If not performed in real-time, it would appear to not meet the intent of the RAO of complete hydraulic capture of groundwater discharge through the site.		See review of Comment # 19 above.
1	**30**	**21**	Section 3.2.2.5.2, page 38, first paragraph (continued from previous page), last sentence: As noted in specific comments 2, 5 and 6, NW Natural should evaluate available drawdown and individual well specific capacities based on the available well test data to support the assumption that higher pump rates in extraction wells are achievable to capture flow in the deep alluvium below the aquitard. At the current design, there is significant uncertainty that control in the Lower Alluvium beneath a relatively continuous aquitard can be achieved with partially penetrating wells in the Lower Alluvium above this aquitard. This uncertainty stems from the following: a. A lack of data and analysis (analytical or numerical modeling) to support this assumption. b. The inefficiencies coupled with available drawdown limitations in the existing extraction wells to realistically increase flow rates significantly enough to indirectly capture deeper groundwater discharging beneath an aquitard.	Anchor QEA disagrees with this characterization. The extensive data collection and modeling efforts completed at DEQ's request provide substantial justification for the current design. We understand that EPA is still reviewing the conclusive findings of hydraulic capture demonstrated in the May 25, 2011 Anchor QEA report *Segment 2 Field Tests of the Programmable Logic Control and Variable Frequency Drive Well Pumps* and recognize that these comments do not necessarily reflect the findings of that report. Further, the characterization of the lower silt as continuous is not correct. The lower silt does not extend under the river so is not laterally continuous. Regardless, the Construction Design Report will restate that NW Natural is committed to achieving hydraulic containment, and it will identify contingencies that could be implemented if needed, such as additional extraction wells.	EPA maintains the intent of this comment is a request for NW Natural to provide additional certainty and justification in the design with supportive analysis and detailed explanation of key concepts. For instance, the concept using the upper alluvium extraction wells to attain hydraulic containment is not fully explained in the Draft Final Design Report text, which is all that EPA has available to review. The available text implies that some pumping influence will be imparted on the lower alluvium wells hydraulically and that a horizontal gradient reversal will be imparted in the deeper portion of the aquifer. However, based on a phone conversation with Anchor QEA on October 5, 2011, we understand that no such influence is intended; rather a vertical gradient reversal will be maintained that will prevent contaminants migrating downward to the reportedly cleaner deeper alluvium. Whether this is a correct interpretation, or not, a more thorough explanation is needed so that the concept of the HC&C design is not misinterpreted. EPA expects to see a full explanation of this concept, with all appropriate illustrations, tables and text along with a full assessment of the water quality of the deeper alluvium and where the deeper alluvium discharges.
1	**31**	**1**	Wall Design, Excavation, Page 2 of text: This section states that "the excavation support method considered for the interceptor is a combination of partial open cut, to a limited depth, and a specialized highly viscous fluid, a Bio-Polymer." However, no details are provided for this excavation sequence and, as noted in the general comments, it is implied that a final design will be prepared that describes the contractor's means and methods. EPA requests the opportunity to review the final design.	The Fill WBZ interceptor trench design was submitted as a final design, and no additional design reports were planned. However, if EPA has additional questions about the current design, please inform DEQ and NW Natural.	See review of Category 1, Item #31, General Comment #1 above.
1	**31**	**2**	Drawing S10 – Products: There are no specifications listed for the Bio-Polymer slurry and slurry enzyme breaker. If these materials are to be provided by the contractor it should be stated as such, with some performance requirements.	This information will be provided in the Construction Design Report.	Response is acceptable pending review of additional information to be provided in the Construction Design Report.
1	**31**	**3**	Drawing S9 and Drawing S10 – Quality Control: The quality control requirements noted are very minimal. A more formal specification should be provided in the final design.	NW Natural would appreciate a clarification on the type of information requested by EPA.	Standard specifications for the type of work implied for the interceptor trench can be developed from standard industry guidelines. NW Natural should engage their engineering consultants for guidance. EPA desires to review this additional information in the Construction Design Report

Category 2 Comments

Category	Item	EPA Comment #	EPA Comments on May 2011 Draft Final Design Report	NW Natural Response provided in November 4, 2011 Letter	EPA Response
2	**13**	**2**	Section 3.1.3, page 13, paragraph 1, 5th sentence: There does not appear to be supportive analysis to provide a basis for the assumption that when a well is shut down for maintenance, other adjacent wells will be capable of increasing their pumping rates to maintain capture. To fully support this assumption, NW Natural should evaluate this analytically and using specific capacities, available drawdown, well yields necessary for capture as derived from modeling simulations, and Segment 2 constant-rate and VFD testing. Based on a preliminary review of available drawdown at current conditions, sustainable extraction rates in the upper alluvium wells are greatly limited with no additional capacity to increase pumping rates to support the loss of an adjacent shutdown well.	Yes, this type of analysis will be done and provided in the Operations Design Report.	EPA believes NW Natural could make more use of data collected from the slug testing and Segment 2 pumping tests to better inform the horizontal and vertical location of the extraction wells and reduce the potential for post construction contingencies. However, if the contingencies (referred to in NW Natural's November 4, 2011 letter) are implemented immediately and effectively as needed and prior to the in-water remedy, the response is acceptable, pending review of additional information to be provided in the Operations Design Report. Please note increasing pumping rates to maintain capture should recognize DEQ's concern over exacerbation of DNAPL migration
2	**14**	**8**	Section 3.2.1.4, page 21, last paragraph: NW Natural states that the model was not modified to reflect the numerous slug test results that indicate the Fill WBZ has an average hydraulic conductivity of less than 1 ft/day. Rather, NW Natural maintained a 10 ft/day assignment to the Fill WBZ in the model. The justification for this is the observation that the model calibrated well using the higher hydraulic conductivity and that a higher hydraulic conductivity assignment is more conservative from the standpoint of determining flow to the proposed interceptor trench and sizing of the pump and treat system. However, EPA believes a sensitivity analysis is needed to assess the degree of influence the lower hydraulic conductivity will have to the extraction system design. Since model simulations will be used to evaluate capture of groundwater at assigned flow rates, the extraction wells currently may show higher than actual pumping capacities as a result of higher recharge assigned in the model. NW Natural should re-run model simulations at hydraulic conductivities determined from site data and with the additional design elements (interceptor trench, paving, etc.) to re-evaluate extraction well placement, capacity limitations, and overall design.	For reasons explained in Appendix A, this type of predictive modeling is proposed to be completed after the extraction system has been installed and pump tested. The findings would be provided in the Operations Design Report, along with design changes or recommendations for contingency measures, if any. The concern that the current design may be based on higher than actual flow rates is unwarranted. NW Natural prefers to have a system that may have too much capacity than one that is inadequate.	Response is acceptable pending review of additional information to be provided in the Operations Design Report. To clarify, EPA's point that the current design may be based on higher than actual flow rates pertains to the model not factoring in hydraulic limitations of the wells. Therefore, even though the model simulates all of the extraction wells pumping 30 gpm at equally spaced distances and creating equally spaced hydraulic containment, the reality is, as demonstrated from the Segment 2 pumping tests, not every well is performing as predicted by the model because of hydraulic limitations, either through engineering, or lithologic variability. These variables have been determined from slug and pumping tests and could be input into the model to re-evaluate the number of extraction wells and their location (both vertically and spatially) and improve the design before construction.
2	**15**	**13c**	c. No analysis of how this intercepted fill water, that naturally recharges the Upper Alluvium, will affect the sustainability (available drawdown) of the Upper and Lower Alluvium extraction wells. Analytical and/or numerical modeling simulations should be prepared to evaluate this potential impact.	The current MODFLOW model does not assume that the Fill WBZ recharge is reduced from paving of the site. Therefore, a revised model that assumes paving is present would reduce the recharge to the Fill WBZ and reduce the modeled downward infiltration to the Upper Alluvium. This would reduce the amount of groundwater that has to be removed by the Upper Alluvium wells, so the current model is conservative with respect to the potential paving.	EPA seeks clarification on NW Natural's response to part c. Segment 2 testing has determined that hydraulic capture of the flux in the fill is unlikely from extraction wells completed in the upper alluvium. EPA understands that this is a primary reason NW Natural has proposed the interceptor trench. If NW Natural believes there is no influence on the Fill WBZ with the HC&C system, then it seems the interceptor trench would be independent of the HC&C system and therefore not rely on the additional operational testing to evaluate its performance. If NW Natural believes there is some hydraulic connection between the upper alluvium and Fill WBZ, then EPA believes it is important to evaluate this using the existing model. Not only will it help evaluate the potential for long-term containment of the Fill WBZ with the HC&C system (possibly reconfiguring the trench design), but also quantify the flow captured by the trench for treatment capacity purposes and optimize its location with the proposed extraction well sites